WHAT IS CLAIMED IS:

1   1.   A method for operating a distributed arbiter for a plurality of resources,

2   comprising:

3   receiving at one of the resources, requests for the one resource from a plurality

4   of requesters; and

5   granting the one resource to one of the requesters according to respective

6   requester priorities, the respective requester priorities being inversely

7   related to a number of requests made respectively, by the requesters.

1   2.   The method as recited in claim 1 further comprising the requesters

2   supplying respective requester priority indications to at least the one resource.

1   3.   The method as recited in claim 2 wherein requesters respectively

2   supply number of requests as requester priority indications.

1   4.   The method as recited in claim 1 further comprising granting at least

2   one of the plurality of resources to a requester according to a round robin scheme,

3   thereby avoiding starvation.

1   5.   The method as recited in claim 1 wherein the one resource provides a

2   grant indication to the one of the plurality of requesters.

1   6.   The method as recited in claim 1 wherein the multiple resources

2   evaluate received requests sequentially.

1   7.   The method as recited in claim 6 wherein resources are considered in

2   an order determined according to resource priority.

1   8.   The method as recited in claim 1 wherein the multiple resources

2   evaluate received requests sequentially, and wherein a requester already granted a

3   resource removes requests for other resources for arbitration for a next sequential

4   resource, thereby preventing requesters from receiving multiple grants during an

5   arbitration cycle.

1   9.   The method as recited in claim 1 wherein requester priorities are

2   recalculated after a resource is granted.

1   10.   The method as recited in claim 1 further comprising the distributed

2   arbiter performing multiple iterations during one arbitration cycle to allocate

3   resources to requesters.

1   11.   The method as recited in claim 9 further comprising requesters

2   recalculating their requests by eliminating requests for a granted resource.

1   12.   The method as recited in claim 1 wherein requesters receive multiple

2   grants from multiple resources during an arbitration iteration.

1   13.   The method as recited in claim 12 wherein a number of arbitration

2   iterations over multiple arbitration cycles varies dynamically.

1   14.   The method as recited in claim 12 wherein the one resource determines

2   which requests to grant in parallel with other resources determining which requests to

3   grant.

1   15.   The method as recited in claim 12 wherein the one resource sends a

2   grant indication to a requester being granted its request.

1   16.   The method as recited in claim 15 wherein the one resource sends a

2   resource priority indication to the requester being granted its request, indicative of a

3   number of requests received by the resource.

1   17.   The method as recited in claim 12 wherein a requester selects from

2   among a plurality of grants according to respective resource priorities associated with

3   each granting resource, the respective resource priorities being inversely related to a

4   number of requests made, respectively, for each granting resource.

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1   18.   The method as recited in claim 17 wherein resource priorities are

2   recalculated each iteration.

1   19.   The method as recited in claim 17 wherein requester priorities are

2   recalculated each iteration.

1   20.   The method as recited in claim 17 further comprising the requester

2   utilizing a round robin scheme to select from among the plurality of grants.

1   21.   The method as recited in claim 20 wherein the round robin scheme is

2   utilized before the requester selects from among the plurality of grants according to

3   the respective resource priorities, the requester selecting from among the plurality of

4   grants according to the respective resource priorities if the round robin scheme does

5   not result in an acceptance of a grant.

1   22.   The method as recited in claim 17 further comprising the requester

2   utilizing a random scheme in addition to using calculated priorities to select from

3   among the plurality of grants.

1   23.   The method as recited in claim 12 wherein the requester being granted

2   its request sends an accept indication to the resource whose grant it is accepting.

1   24.   The method as recited in claim 23 wherein a requester determines

2   which of one or more grants to accept, in parallel with other requesters determining

3   which received grants to accept.

1   25.   The method as recited in claim 1 wherein the resources do not transmit

2   grant indications to requesters, each requester determining grant values according to

3   received information from other requesters.

1   26.   The method as recited in claim 25 wherein requesters and resources are

2   synchronized in regards to round robin positions.

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1   27.   The method as recited in claim 2 wherein each of the requesters

2 provides an indication of priority on a bus logically combining the indications of

3 priority, the priority being related to a number of requests being made by each of the

4 requesters.

1   28.   The method as recited in claim 27 wherein the indications of priority

2 are unary coded, one bit corresponding to one request.

1   29.   The method as recited in claim 28 wherein the bus logically combines

2 the indications of priority.

1   30.   The method as recited in claim 28 wherein the indications of priority

2 are a number of requests of respective requesters.

1   31.   The method as recited in claim 28 further comprising a requester

2 responding to the priority indication on the bus by not sending a request if the priority

3 indication on the bus indicates a higher priority requester is requesting a resource.

1   32.   The method as recited in claim 1 wherein the requesters are nodes of a

2 network coupled to input ports of a network switch and the resources are output ports

3 of the network switch, multiple ones of the output ports being accessible to more than

4 one of the input ports.

1   33.   The method as recited in claim 1 wherein the requesters are processors

2 of a multi-processor system and the resources are memories coupled to the processors,

3 each of the memories being accessible to more than one of the processors.

1   34.   The method as recited in claim 1 further comprising recalculating

2 requester priorities after each time a resource is granted to a requester.

1   35.   An arbitration apparatus for arbitrating requests from a plurality of

2 requesters for a plurality of resources, comprising:

3   means for receiving requests for resources from the requesters; and

4   means for granting requests according to requester priorities, the requester

5   priorities being inversely related to the number of requests respectively

6   made by the requesters.

1   36.   The arbitration apparatus as recited in claim 35 further comprising:

2   means for selecting from among a plurality of grants according to resource

3   priorities, the resource priorities being inversely related to the number

4   of requests made for the respective resource.

      37.   The arbitration apparatus as recited in claim 36 further comprising

2   means for preventing starvation for grants.

1   38.   The arbitration apparatus as recited in claim 35 further comprising

2   means for preventing starvation for requests.

1   39.   The arbitration apparatus as recited in claim 35 wherein the arbitration

2   apparatus is one of distributed arbiter and a centralized arbiter.

1   40.   A distributed arbiter comprising:

2   a plurality of requesters;

3   a plurality of resources coupled to the requesters through a transport

4   mechanism;

5   wherein each requester is coupled to provide to each resource requested by the

6   respective requester, a request indication; and

7   wherein a requested resource is responsive to a plurality of requests to

8   selectively grant one of the requests according to requester priorities,

9   the requester priorities being inversely related to a number of requests

10   being made by respective requesters.

1   41.   The distributed arbiter as recited in claim 40 wherein the requested

2   resource is further responsive to the plurality of requests to selectively grant one of

3   the requests according to a round robin mechanism.

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1   42.   The method as recited in claim 41 wherein the round robin mechanism

2   is utilized before the requested resource selects from among the plurality of requests

3   according to the requester priorities, the requested resource granting one of the

4   requests according to the requester priorities if the round robin mechanism does not

5   result in a grant.

1   43.   The distributed arbiter as recited in claim 40 wherein each requester

2   requesting the requested resource respectively provides a requester priority indication

3   to the requested resource.

1   44.   The distributed arbiter as recited in claim 43 further comprising a bus

2   coupled to the requesters and resources, and wherein each of the requesters provides

3   an indication of priority on a bus, the bus logically combining the indications of

4   priority, the priority being inversely related to a number of requests being made by

5   each of the requesters.

1   45.   The distributed arbiter as recited in claim 44 wherein the indications of

2   priority are unary coded.

1   46.   The distributed arbiter as recited in claim 44 wherein a bus implements

2   a wired-NOR of the indications of priority.

1   47.   The distributed arbiter as recited in claim 44 wherein each requester

2   places a unary encoded number of requests on the bus as the indication of priority.

1   48.   The method as recited in claim 44 wherein a requester with a lower

2   priority than indicated on the bus is responsive to the priority indicated on the bus to

3   not send its request to a resource.

1   49.   The distributed arbiter as recited in claim 40 wherein the requested

2   resource provides a grant indication to a requester whose request is being granted by

3   the resource.

1   50.   The distributed arbiter as recited in claim 40 wherein the requested

2 resource is further coupled to provide an indication of resource priority, the resource

3 priority being inversely related to a number of resource requests received by the

4 requested resource.

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51.   The distributed arbiter as recited in claim 40 wherein a requester is

2 responsive to receiving a plurality of grants from a plurality of resources to accept one

3 of the grants according to priorities of the grants, the priorities being inversely related

4 to a number of requests received by resources.

1   52.   The distributed arbiter as recited in claim 51 wherein the requester

2 accepts a grant indicating a particular resource is being allocated to the requester,

3 according to a starvation avoidance mechanism in addition to the priorities.

1   53.   The distributed arbiter as recited in claim 40 wherein a requester is

2 responsive to receiving a plurality of grants from a plurality of resources to accept one

3 of the grants according to a random priority determined for the grants.

1   54.   The distributed arbiter as recited in claim 40 wherein the requesters are

2 nodes of a network coupled to input ports of a network switch and the resources are

3 output ports of the network switch, multiple ones of the output ports being accessible

4 to more than one of the input ports.

1   55.   The distributed arbiter as recited in claim 40 wherein the requesters are

2 processors of a multi-processor system and the resources are memories coupled to the

3 processors, each of the memories being accessible to more than one of the processors.

1   56.   A computer program product encoded in at least one computer

2 readable medium to implement an arbitration mechanism to allocate a resource to

3 requesters, the computer program product comprising:

4   a first instruction sequence executable to receive requests for one of the

5   resources from multiple requesters; and

6   a second instruction sequence executable to allocate the one resource to one of

7   the requesters according to requester priorities, requester priorities

8   being inversely related to a number of requests made by each requester

9   for the resources; and

10   wherein the at least one computer readable medium is selected from the set of

11   a disk, tape or other magnetic, optical, or electronic storage medium

12   and a network, wireline, wireless or other communications medium.

1   57.   The computer program product as recited in claim 56 wherein the

2   computer program product further includes a starvation avoidance instruction

3   sequence executable to implement a starvation avoidance mechanism.

1   58.   A computer program product encoded in at least one computer

2   readable medium to implement an arbitration mechanism to determine which of a

3   plurality of grants received by a requester from a plurality of resources, to accept, the

4   computer program product comprising:

5   a first instruction sequence executable to receive an indication of the grants for

6   respective resources; and

7   a second instruction sequence executable to accept one of the grants according

8   to grant priorities, grant priorities being inversely related to a number

9   of requests received by a resource.

1   59.   The computer program product as recited in claim 58 wherein the

2   computer program product further includes a starvation avoidance instruction

3   sequence executable to implement a starvation avoidance mechanism to accept one of

4   the grants.

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